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Harding Lawson Associates

Final
Phase 2 Treatability Study Work Plan
Pilot Scale Groundwater Treatment System
Baldwin Park Operable Unit
San Gabriel Basin, California

Engineering and Environmental Services

HLA

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Pilot Scale Groundwater Treatment System
Baldwin Park Operable Unit
San Gabriel Basin, California

Prepared for

Baldwin Park Operable Unit Steering Committee

HLA Project No. 39856 210

February 12, 1999

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1.0 INTRODUCTION

For the past several years, the Baldwin Park Operable Unit Steering Committee (BPOUSC), the U.S. EPA Region IX (EPA), the Main San Gabriel Basin Watermaster (Watermaster) and Three Valleys Municipal Water District (TVMWD), in association with the Metropolitan Water District of Southern California (MWD), have been planning a combined groundwater remediation and water supply project in the San Gabriel Basin, California. Project planning was initiated in response to a requirement of EPA to remediate various plumes of volatile organic compounds (VOCs) in groundwater in the cities of Azusa and Baldwin Park. These plumes extend from north of Interstate 210 in the city of Azusa southwest to locations in the vicinity of Interstate 10 in the city of Baldwin Park. This area is called the Baldwin Park Operable Unit (BPOU).

In June 1997 concentrations of perchlorate ion above the recently issued State of California Department of Health Services (DHS) action level of 18 micrograms per liter (μg/l) were detected in BPOU groundwater. Before the BPOU project could move forward, the potential impact of perchlorate on the conceptual project design had to be evaluated. At the time it was discovered in BPOU groundwater, perchlorate was considered troublesome because no treatment technology had been demonstrated to be effective in reducing concentrations of perchlorate to the action level.

Pilot-scale perchlorate treatability testing was performed at the Aerojet-General Corporation (Aerojet) facility near Sacramento, California in 1997. The technology tested was a biological reduction process using a fixed film attached to granular activated carbon, operated as a fluidized bed (GAC/FB) bioreactor. This pilot-scale test demonstrated the technology was effective in treating perchlorate in groundwater. There were, however, several important differences between objectives of this previous pilot-scale work and current objectives for the BPOU project. First, the flow rate was 0.1 percent of that needed in the San Gabriel Basin. Second, the influent perchlorate concentration was over 100 times that expected in the San

Gabriel Basin. Third, the Pilot System was not designed to achieve nor did it achieve effluent perchlorate concentrations less than the 18 µg/l action level. Finally, the previous testing was not designed to document that the treatment process produced potable water.

To further develop the biological reduction process for application in the San Gabriel Basin, a Phase 1 Treatability Study was performed at Aerojet's Sacramento, California facility. This treatability study was performed between November 1997 and May 1998. The results of this study have been documented in *Draft Final Report, Phase 1 Treatability Study* (Harding Lawson Associates [HLA] 1997a). In summary, the Phase 1 Treatability Study demonstrated that the biological reduction method using GAC/FB technology successfully reduced low concentrations of perchlorate to concentrations below the 4 µg/l laboratory reporting limit. At the same time, concentrations of nitrate were reduced from approximately 10 milligrams per liter (mg/l) (as nitrogen) to less than the laboratory reporting limit of 0.1 mg/l. Additionally, the alternative source of microorganisms used for the biological process proved to be satisfactory in building the microbial population needed to destroy perchlorate and nitrate. Operational controls (e.g., hydraulic retention time, recycle ratio, ethanol dose, and phosphorus dose) were evaluated to establish the design criteria necessary to ensure successful treatment operations. The Phase 1 Treatability Study also identified several monitoring parameters that could be used to guide optimum system performance.

Although a considerable amount of information was obtained from the Phase 1 Treatability Study, several important issues require further evaluation. For the Phase 2 Treatability Study, scale-up factors will be evaluated from the Phase 1 flow (25 gallons per minute [gpm]) to the Phase 2 flow (500 gpm) which can then be used in design of a full-scale system (20,000 to 23,000 gpm). The Phase 1 system was located in Sacramento and used a water source which had similar, but not identical, water quality characteristics to that of San Gabriel Basin groundwater. The Phase 2 Pilot System will be located at a site owned by the La Puente Valley County Water District (LPVCWD) in the San Gabriel Basin. Finally, the Phase 1 treatment system was not designed to produce potable water. The Phase 2 Pilot System will include all of the unit processes required to produce potable water.

Following issuance of the Draft Phase 2 Treatability Study Work Plan in May 1998, n-nitrosodimethylamine (NDMA) and 1,4 dioxane were detected in BPOU groundwater. The discovery of NDMA prompted a change in the treatment strategy proposed for the Phase 2 Pilot System. NDMA is neither adsorbable nor strippable, but can be effectively destroyed by ultraviolet (UV) irradiation. UV irradiation, with the addition of an oxidizing chemical (e.g., hydrogen peroxide), is also an effective treatment for removal of VOCs and 1,4 dioxane. Therefore, air stripping, which was originally proposed for removal of VOCs, was replaced with UV/oxidation. Liquid-phase granular activated carbon (GAC) contactors were also added for removal of carbon tetrachloride, which is not removed by UV/oxidation. Therefore, the purpose of the Phase 2 Treatability Study has grown from a demonstration where perchlorate is removed and potable water produced, to an evaluation of a complex treatment train capable of treating a wide variety of chemicals and providing multiple treatment barriers for this potable supply system.

This revised treatment train offers additional advantages over the previously proposed treatment train. Liquid-phase GAC (located at the end of the treatment train prior to disinfection) will provide a final polishing step and act as a second barrier to any adsorbable compounds. UV/oxidation will provide for pathogen destruction prior to the addition of chlorine should they be present, will lower the formation potential for disinfection byproducts (DBPs), and will remove vinyl chloride and other potential byproducts of the biological reduction process, if they are present in the treated water at this point in the treatment train.

The purpose of the Phase 2 Treatability Study is to demonstrate that the proposed treatment train will effectively and reliably produce potable water pursuant to all applicable state and federal regulations, optimize the system operating parameters, and collect data for the design and construction of a full-scale treatment facility.

2.0 HISTORY OF PERCHLORATE ISSUES

In February 1997, perchlorate was detected in five drinking water supply wells in Sacramento, California. This discovery was a result of a recent improvement in the analytical method allowing the detection of perchlorate in water at concentrations below the action level (18 µg/l). After the detection of perchlorate in Sacramento water supply wells, DHS performed groundwater sampling and analysis for perchlorate in other portions of the state including the San Gabriel Basin.

2.1 Distribution of Perchlorate in the BPOU

Perchlorate was first detected in San Gabriel Basin groundwater in June 1997 by DHS. This prompted the Watermaster and the BPOUSC to perform additional groundwater sampling and analysis to better understand the distribution of perchlorate in groundwater.

To date, the BPOUSC and Watermaster have compiled perchlorate data for over 50 monitoring wells, production wells, and sampling points in the vicinity of the BPOU. Perchlorate analyses for water supply production wells were performed on samples obtained by the DHS and Watermaster and provided by the San Gabriel Basin Water Quality Authority (SGBWQA). Groundwater samples from monitoring wells in the BPOU were collected by Camp Dresser McKee (CDM), HLA, and Geosyntec on behalf of the BPOUSC.

The lateral and vertical distribution of perchlorate in groundwater has been previously described (see *Distribution and Treatability of Perchlorate in Groundwater, Baldwin Park Operable Unit, San Gabriel Basin* [HLA, 1997b], *Final Addendum to Sampling and Analysis Plan, Pre-Remedial Design Groundwater Monitoring Program, Baldwin Park Operable Unit, San Gabriel Basin* [HLA, 1997c], and *Draft Phase 2A Monitoring Well Installation and Groundwater Sampling Report, Baldwin Park Operable Unit, Pre-Remedial Design Program* [HLA, 1998]). In general, the area that contains concentrations greater than the DHS action level of 18 µg/l is 5 to 6 miles in length, oriented from northeast to southwest, is approximately 1 mile in width, and up to 800 feet in depth. This approximate perchlorate distribution is based on maximum concentrations detected in any sample or at any depth within a given well.

It should be noted that there is uncertainty regarding the concentrations above the 18 µg/l action level in both the northernmost and southernmost portions of the plume. It should also be noted that there appears to be several sources of perchlorate in the San Gabriel Basin, and that there are anomalous detections in portions of the basin that cannot be explained or that may be the result of laboratory interferences. Therefore, the known perchlorate distribution may change as wells are resampled or as new wells are constructed and sampled.

2.2 Toxicity/Provisional Action Level

In February 1997, the DHS set a provisional action level for perchlorate in groundwater at 4 µg/l, but at that time, laboratory methods were not designed or approved to measure concentrations this low. In May 1997, based on recommendations from EPA, DHS established a range of 4 µg/l to 18 µg/l that it considers consistent with the range of perchlorate exposures, which are protective of human health. DHS set their action level at 18 µg/l and require that water suppliers promptly notify customers whenever perchlorate is present in concentrations greater than 18 µg/l.

In April 1993, the Perchlorate Study Group (PSG) was formed by the U.S. Air Force, various aerospace companies, and the two primary manufacturers of perchlorate compounds. The mission of the PSG was to review and evaluate information on the toxicity of perchlorate and develop better information on what constitutes an acceptable level of perchlorate in soil and groundwater. More recently (1997), the PSG initiated toxicological studies for the purpose of developing a provisional reference dose (RfD) that will be more reflective of exposure to low levels of perchlorate in water. Initial testing has been completed and the EPA National Center for Environmental Assessment (NCEA) recently issued a recommended reference does of 32 µg/l. This recommended reference does is presently undergoing peer review.

3.0 PERCHLORATE TREATMENT BY BIOLOGICAL REDUCTION

Following the detection of perchlorate in groundwater at Aerojet's Sacramento facility, technology screening, bench-scale studies, and pilot-scale studies were performed by Aerojet and its consultants to address the treatability of perchlorate-contaminated groundwater. This work culminated in the design and construction of a 2,000-gpm treatment system that utilizes the process of biological reduction to remove perchlorate from groundwater. This work is described in other documents (HLA 1997a, 1997b, 1998). The proposed Phase 2 Treatment System for the BPOU Consensus Project will utilize the same biological process for perchlorate reduction.

3.1 Conceptual Model of Biological Perchlorate Reduction

The proposed mechanism for biological reduction of perchlorate to chloride, carbon dioxide, and water, with the simultaneous biochemical oxidation of an organic substrate under anoxic conditions, is analogous to that of biological denitrification. Biological denitrification is the reduction of nitrate (NO_3^-) to nitrogen gas (N_2) with the simultaneous biochemical oxidation of an organic substrate under anoxic conditions by facultative microorganisms.

Biological denitrification involves both assimilative and dissimilative nitrate reduction. In the assimilative nitrate reduction process, nitrate is converted to ammonia for use by the cells in biosynthesis and occurs when nitrate is the only form of nitrogen available. In the dissimilative nitrate reduction process, microorganisms oxidize an organic substrate (electron donor) to obtain energy for cell growth and maintenance and utilize nitrate as the electron acceptor (in the absence of oxygen), which is reduced to nitrite (NO_2^-), then to nitric oxide (NO), then to nitrous oxide (N_2O), and finally to nitrogen gas (N_2). Biological denitrification will only occur under anoxic conditions because oxygen is preferred over nitrate as an electron acceptor. The term "anoxic" is used in preference to the term "anaerobic" because the principle biochemical pathways involved in biological denitrification are not anaerobic but only modifications of aerobic pathways (i.e., nitrate is used as the electron acceptor instead of oxygen).

Using ethanol as the carbon source, nitrate as the nitrogen source and electron acceptor, and assuming that 30 percent of the ethanol is used for cell synthesis and 70 percent for energy conversion (McCarty et al., 1969), the stoichiometry of denitrification can be described by the following empirical equation:

$$NO_3^- + 0.553\ CH_3CH_2OH + H^+ \rightarrow 0.071\ C_5H_7O_2N + 0.464\ N_2 + 0.75\ CO_2 + 1.910\ H_2O$$

where:

CH_3CH_2OH = Ethanol
$C_5H_7O_2N$ = Emperical Formula for Cell Mass

This balanced empirical equation indicates that for every mole of nitrate reduced, 0.553 moles of ethanol are consumed. This results in an empirical ethanol requirement of 1.817 milligrams of ethanol per milligram of nitrate-nitrogen reduced. This ethanol requirement applies only to nitrate reduction and does not include other potential electron acceptors such as oxygen and perchlorate.

Using oxygen as the electron acceptor (which is reduced to water), nitrate as the nitrogen source, and ethanol as the carbon source, the stoichiometry can be described by the following empirical equation:

$$O_2 + 0.061\ NO_3^- + 0.476\ CH_3CH_2OH + 0.061\ H^+ \rightarrow 0.061\ C_5H_7O_2N + 0.646\ CO_2 + 1.245\ H_2O$$

This balanced equation results in an empirical ethanol requirement of 0.685 milligrams of ethanol per milligram of molecular oxygen reduced to water.

The proposed mechanism for reduction of perchlorate (ClO_4^-) is analogous to nitrate reduction except that perchlorate is used as the electron acceptor. Perchlorate is first reduced to chlorate (ClO_3^-), then to chlorite (ClO_2^-), then to hypochlorite (OCl^-), and finally to chloride ion (Cl^-). As in nitrate reduction, ethanol is the carbon source and nitrate is the nitrogen source. The stoichiometry can be described by the following empirical equation:

$$ClO_4^- + 0.122\ NO_3^- + 0.952\ CH_3CH_2OH + 0.122\ H^+ \rightarrow 0.122\ C_5H_7O_2N + Cl^- + 1.293\ CO_2 + 2.490\ H_2O$$

This balanced equation results in an empirical ethanol requirement of 0.442 milligrams of ethanol per milligram of perchlorate reduced to chloride ion.

The total ethanol requirement can then be computed using the following empirically derived equation:

$$C_e = 1.817\ NO_3^- + 0.685\ O_2 + 0.443\ ClO_4^-$$

where:

C_e = required ethanol concentration (mg/l)
NO_3^- = initial nitrate-nitrogen concentration (mg/l)
O_2 = initial dissolved oxygen concentration (mg/l)
ClO_4^- = initial perchlorate concentration (mg/l)

This equation is slightly conservative in that it assumes that all of the nitrate is consumed by denitrification. A small amount of nitrate is also incorporated into cell mass during oxygen and perchlorate reduction.

This empirical equation illustrates the importance of dissolved oxygen in the reduction of nitrate and perchlorate. Biological contact time and ethanol requirements will both increase as influent dissolved oxygen increases because oxygen must first be reduced to trace levels before denitrification can commence. Increasing influent dissolved oxygen will therefore increase capital and operating costs for any treatment process utilizing biological reduction for nitrate or perchlorate removal.

The empirical equations presented in this section provide a good conceptual model for reduction of oxygen, nitrate, and perchlorate. However, the metabolic breakdown of ethanol is a complex process that has been widely studied but has not been completely quantified. There are a variety of classes of organic compounds that are intermediates and potential byproducts of this process, including aldehydes, ketones, and carboxylic acids. Acetic acid and formic acid are likely intermediates in the acid fermentation of ethanol. Other potential byproducts include acetone, 2-butanone, propionaldehyde, formaldehyde, and acetaldehyde. The potential formation of byproducts and intermediates (other than CO_2 and H_2O) have been addressed in design of the overall treatment train recommended for the Phase 2 Treatability Study. Incomplete oxidation of ethanol may result in a higher required ethanol dosage than predicted by the above empirical equation for total ethanol requirement.

The reduction of oxygen, nitrate, and perchlorate, as presented in this section, are categorized as biologically mediated oxidation-reduction reactions. Given the nature of these reactions, the oxidation-reduction potential (ORP) of the water is an important indicator. A high ORP value indicates an oxidizing environment while a low ORP value (especially negative) indicates a reducing environment. Nitrate and perchlorate reduction require a reducing environment for the reactions to proceed as shown in this section. Once a correlation between ORP and nitrate and perchlorate reduction is established for a given water quality, this correlation can be used to monitor and control a biological reduction system. This approach is feasible with a water source that has a relatively consistent water quality profile, as would be expected from the deep aquifer selected for the Phase 2 Treatability Study.

3.2 Phase 1 Treatability Study Results

The Phase 1 Treatability Study results confirmed that nitrate and perchlorate could be effectively removed at concentrations representative of San Gabriel Basin groundwater. When influent dissolved oxygen concentrations were low and adequate ethanol dosages were added, complete destruction of both nitrate and perchlorate were observed. Phase 1 results are discussed in detail in a previous report (HLA, 1997a).

Optimum ethanol dosage was determined to be approximately 40 mg/l for the Phase 1 Treatability Study during the low influent DO period. This concentration is approximately 43 percent higher than predicted by the empirical ethanol requirement equation developed in the previous section. Optimization of ethanol dosage will continue in the Phase 2 Treatability Study. Effluent water quality will be monitored to determine when steady-state conditions are attained.

ORP data collected during Phase 1 indicated that an ORP of less than approximately –250 millivolts (mV) corresponded to complete nitrate and perchlorate reduction. The Phase 2 Treatability Study will include on-line instrumentation at several points in the biological process to monitor and record ORP for continued evaluation as a control parameter. The biological process will be controlled manually during the treatability study until it can be demonstrated that ORP is an effective and reliable control parameter.

3.3 Full-Scale System in Sacramento

Aerojet has constructed a 2,000-gpm perchlorate treatment system at its Sacramento facility. The system has been operating since January 1999, but preliminary performance data are not yet available. Two bioreactors have been constructed each with a design flow rate of about 1,000 gpm. Each bioreactor is 14 feet in diameter and 22 feet tall. Under normal operating conditions the biomass bed depth is approximately 15 feet. Effluent from the bioreactors flows through continuous backwash sand filters to remove biomass and particulates. Ultimately two additional bioreactors, each with a design flow rate of 1,000 gpm, are planned at this location.

Performance data from Aerojet's Sacramento treatment system, along with the Phase 1 Treatability Study results, will be used during design and operation of the Phase 2 system.

4.0 PHASE 2 OBJECTIVES

The Phase 2 Treatability Study objectives are to confirm the destruction/removal efficiency of each unit process in the treatment train, the treated water quality for the entire system, optimize the operating parameters for each unit process, collect data to support the permitting of the facility as a potable water source, and collect data required for the design and construction of a full-scale treatment system.

4.1 Confirm Destruction/Removal Efficiencies

The primary objective of the Phase 2 Treatability Study is to confirm the ability of the treatment train to remove or destroy the contaminants of concern including perchlorate, VOCs, nitrate, 1,4 dioxane, and NDMA, and produce treated water that meets drinking water standards. Because each unit process in the treatment train will be used to treat specific contaminants, the water quality for each unit process, as well as for the overall system will be tested during the pilot study.

Specific sampling and analysis protocols will be detailed in a Sampling and Analysis Plan (SAP), which will be prepared as part of the Operation and Maintenance (O&M) Manual for the Treatment System. Individual unit operations and the contaminants to be removed by each system are summarized below:

- **Bioreactor**
  - Nitrate
  - Perchlorate
- **Multimedia Filters**
  - Suspended Solids
  - Ethanol and breakdown products
  - Viruses and coliform bacteria

- **UV/ Oxidation System**
  - VOCs
  - NDMA
  - 1,4 dioxane
  - Viruses and coliform bacteria
- **Liquid Phase Granular Activated Carbon**
  - Carbon Tetrachloride
  - DBP Precursors
- **Disinfection System**
  - Viruses and coliform Bacteria

4.2 Establish Operating Parameters

A second objective of the Phase 2 Treatability Study is to collect data to optimize the operation of each unit process and the treatment system as a whole. This objective will be accomplished by varying the operating conditions for each unit process and using the readings from local instrumentation and the results of sample collection and analysis to evaluate system response. The optimization will focus on maximizing system throughput and efficiency of unit operations while maintaining treated water quality. It will also include characterizing the treatment process' response to plausible operational problems and perturbations to verify the Phase 1 findings. Specific procedures for optimizing each unit operation will be prepared as part of the O&M Manual. These procedures will include physical parameters that can be varied to affect system performance such as flow rates, hydraulic loading rates, and chemical feed dosages as well as parameters that can be measured to assess system performance such as pH, ORP, dissolved oxygen (DO), and sampling results for a multitude of analytes. The following is a summary of key operating parameters for each unit process. Each listed parameter followed by a (v) can be varied to affect system performance. Listed parameters followed by a (p) signify that the parameter is an indicator of system performance, but is not a parameter that can be adjusted to control system performance.

- **Bioreactor**
  - Recycle ratio (v)
  - Ethanol dosage (v)
  - Phosphorous dosage (v)
  - Hydraulic loading rate (v)
  - Nitrate concentration (p)
  - Perchlorate concentration (p)
  - DO profile (p)
  - ORP profile (p)
  - Effluent turbidity (p)
  - Effluent ethanol (and breakdown products) concentration (p)
  - Mean cell residence time (p)
  - Substrate utilization rate (p)
  - Food to microorganism (F/M) ratio (p)
- **Multimedia Filters**
  - Surface loading rate (v)
  - Polymer dosage (v)
  - Filter cycle time (v)
  - Turbidity (effluent and backwash) (p)
  - Particle count (influent and effluent) (p)
  - Ethanol (and breakdown products) concentration (influent and effluent) (p)
  - Suspended solids (p)
  - Virus and bacteria removal (p)
  - DO concentration (influent and effluent) (p)

- **UV/ Oxidation System**
  - UV power (v)
  - Hydrogen peroxide dosage (v)
  - VOC concentrations (influent and effluent) (p)
  - NDMA concentration (influent and effluent) (p)
  - 1,4 dioxane concentration (influent and effluent) (p)
- **Liquid Phase Granular Activated Carbon**
  - VOC concentrations (influent and effluent) (p)
  - GAC bed life (p)
- **Disinfection System**
  - Sodium hypochlorite dosage (v)
  - Chlorine contact time (v)
  - Microbial water quality (p)
  - Residual chlorine concentration (p)

4.3 Collect Data to Support Permitting as Potable Water Source

Another objective of the Phase 2 Treatability Study is to demonstrate a reliable, stable treatment process and to collect data to support the rigorous application requirements for a permit to operate the Pilot System as a potable water source. Data will also be collected for evaluation of the formation of DBPs. DBPs are compounds that form as a result of a chemical process not proceeding to completion, the breakdown of a chemical involved in the process, or chemicals in the process combining in unintended ways. Examples of this are the formation of chlorite (ClO_2^-) or chloroform ($CHCl_3$) from disinfection by chlorination, or fluoroacetic acid ($C_2F_3O_2H$) from fluorination. DBP formation can often be mitigated by modifying one or more system operating parameters (e.g. chemical dosages, pH, ORP, temperature, pressure). The absence of flocculation and sedimentation in the treatment train will require that the proposed filtration system be certified (The same is true if the proposed filtration rate exceeds 6 gallons per minute per square foot (gpm/ft^2), the maximum rate specified in Title 22).

The biological inoculum used to seed the growth of biomass will be characterized to identify the microorganisms present, particularly human pathogens. The proposed microorganism inoculum originates from a wastewater sump in a baby food processing plant. The microorganisms' environment is aerobic. This source of microorganisms was selected because of the stringent monitoring for human pathogens in the baby food processing industry. Other alternatives are also being considered such as biomass from the existing bioreactors at the Aerojet's Sacramento facility or biomass purchased from a commercial source. The characterization of the inoculum is to further screen for human pathogens and includes bacteriology (total and fecal coliform and heterotrophic plate count), giardia and cryptosporidium, and viruses. Taste, color, and odor, and the potential for biological growth in the distribution system will also be addressed.

Specific data collection plans will be prepared for each area and included as part of the SAP for the Pilot System. Input from the appropriate agencies, such as the DHS Drinking Water Branch, Watermaster, and the MWD will be solicited during preparation of these plans.

4.4 Collect Data to Support Design of Full-Scale System

The final objective of the Phase 2 Treatability Study is to collect data and practical operating information to support the design, construction, and operation of a full-scale treatment system. The information collected during operation of the Pilot System including analytical data, instrument readings, power consumption data, removal efficiencies, hydraulic loading rates, control logic functionality, and maintenance requirements will be taken into consideration during the conceptual and detailed design of a full-scale treatment system.

5.0 TREATMENT SYSTEM DESIGN

5.1 Conceptual Design

The treatment train for the Phase 2 Treatment System is designed to progressively remove contaminants from the water using a series of unit operations. The unit operations are sequenced to provide maximum removal efficiencies while minimizing potential interferences with downstream processes. The sequence of treatment operations will enable the treatment system to meet effluent requirements while minimizing costs and waste production. The treatment train is designed to be a multi-barrier system with respect to both chemical and biological contaminants. The ultimate objective of the treatment system is to demonstrate the ability of this treatment train to reliably treat the extracted groundwater to provide potable water meeting all applicable state and federal requirements for chemical and biological contaminants, turbidity, color, odor, and residual disinfectant concentration.

5.2 Treatment Unit Processes

The treatment train includes a fluidized bed bioreactor, multimedia filters, UV/oxidation, GAC adsorption, and disinfection. The proposed process flow diagram for the system is presented in Figure 5.1.

5.2.1 GAC/FB Bioreactor

The GAC/FB bioreactor is designed to remove nitrate and perchlorate under anoxic conditions. The influent groundwater will be fed into the bottom of the reactor through a network of nozzles. The upward velocity of the water will fluidize the GAC media contained in the reactor. The fluidized media provides extensive surface area for growth of microorganisms. Ethanol will be fed into the bioreactor to serve as a carbon source for growth of microorganisms. The small amount of DO in the influent groundwater will be quickly utilized via aerobic breakdown of the ethanol, creating an anoxic condition in the bioreactor. Under these conditions, facultative organisms will utilize nitrogen and perchlorate as electron acceptors while metabolizing ethanol. Nitrate will be reduced to nitrogen gas, and perchlorate will be reduced to chloride ion.

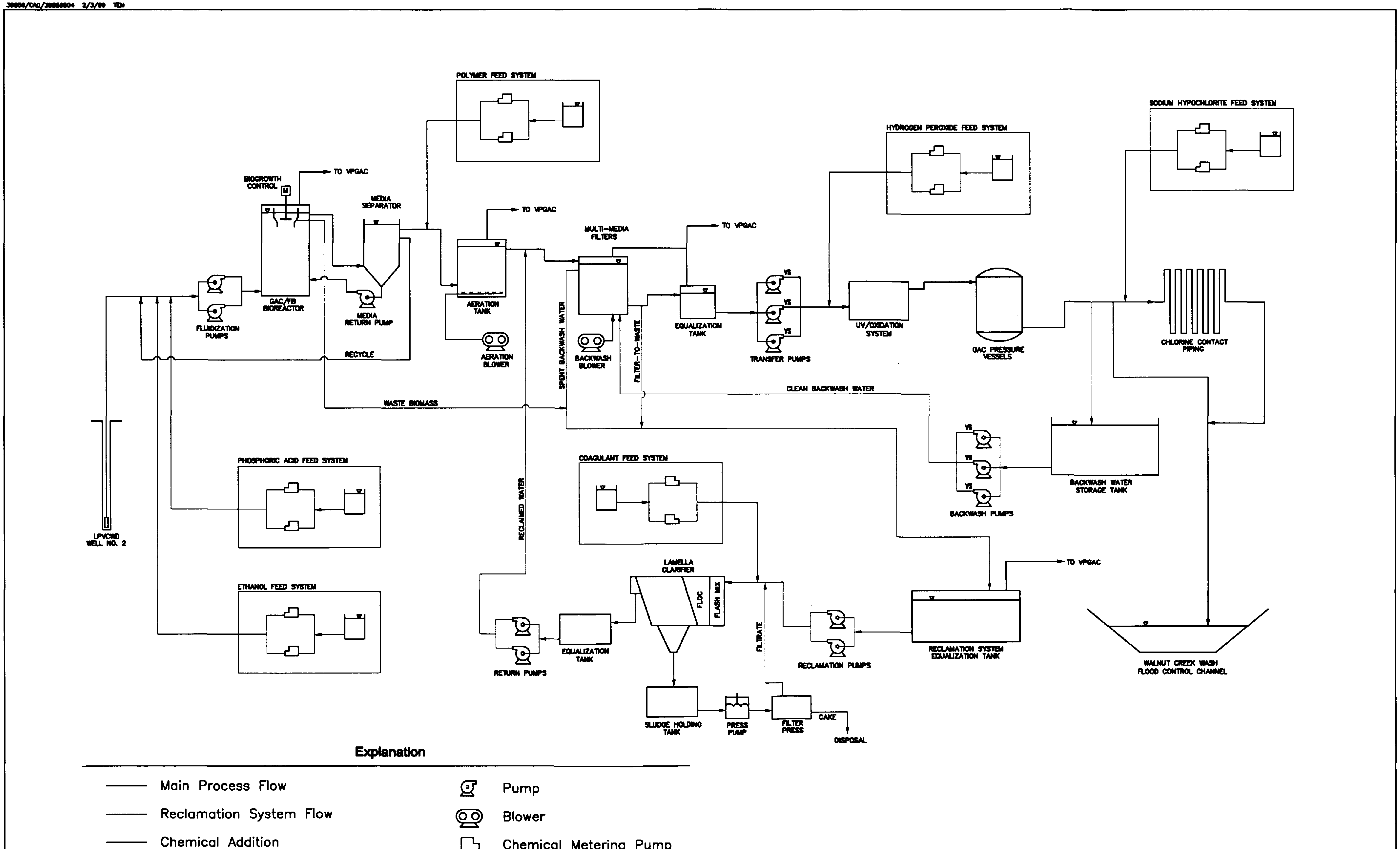
The bioreactor is the first unit operation in the treatment train because nitrate interferes with the UV/chemical oxidation system and the very low DO levels present in the groundwater are conducive to developing anoxic conditions within the reactor. As discussed in Section 3.0, minimizing influent DO concentration also minimizes the contact time required in the bioreactor and reduces the required ethanol dosage. Low influent DO concentrations ensure that aerobic activity is limited to a small portion of the bottom of the bioreactor, leaving most of the bioreactor column available for nitrate and perchlorate reduction.

Following treatment in the bioreactor, a post-aeration tank will be used to raise the DO level in the groundwater to a level (approximately 4 to 5 mg/l) sufficient to maintain aerobic conditions in the multimedia filters, which will be operated in a biologically active mode. In the aeration tank, air will be gently sparged into the water to raise the DO level while minimizing stripping of VOCs. The tank will be covered and will vent through a vapor phase GAC adsorber.

5.2.2 Multimedia Filters

The multimedia filters will remove suspended solids from the bioreactor overflow and will provide biological degradation of residual ethanol and metabolic byproducts not fully removed in the bioreactor. A backwash pump and tank will be activated based on head loss across the filter or turbidity in the filter effluent to backwash individual filters as they become loaded with solids. Two filters will be installed so that system operation can continue during backwash cycles and to provide operational flexibility so that the filtration rate can be optimized during operation of the treatment system.

The multimedia filters are positioned between the bioreactors and the UV/oxidation system in the treatment train. This positioning allows removal of suspended biomass and GAC fines that could interfere with the performance of the UV/oxidation system, and so that excess ethanol or ethanol breakdown



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Process Flow Diagram

Phase 2 Treatability Study Pilot Plant
Baldwin Park, California

Figure 5.1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
TEM	39856,210		12/98	2/99

products can be biologically degraded before entering the UV/oxidation system and thereby avoid increasing peroxide demand.

5.2.3 UV/oxidation

The UV/oxidation system will oxidize VOCs, NDMA, and 1,4 dioxane using a combination of ultraviolet (UV) light and hydrogen peroxide. The effectiveness of this technology for destruction of NDMA and 1,4 dioxane, as well as many VOCs is well documented. The UV light reacts with the hydrogen peroxide to form hydroxyl radicals, which are extremely reactive. The hydroxyl radicals will rapidly react with the contaminants remaining in the groundwater, with the exception of carbon tetrachloride. In general, reaction with UV light, hydrogen peroxide, or hydroxyl radicals will cleave a contaminant molecule into two or more breakdown products which, in turn, react with the oxidants in successive steps to the end products CO_2, H_2O, and Cl-.

This system is positioned after the bioreactor and the multimedia filters in the treatment train so that nitrate and suspended solids, which interfere with the UV/oxidation process, are removed from the water before it enters the UV/oxidation system. In addition, the multimedia filters will be biologically active and will remove excess ethanol or ethanol breakdown products upstream of the UV/oxidation system to minimize ancillary consumption of UV light, hydrogen peroxide, and hydroxyl radicals.

5.2.4 Liquid Phase Granular Activated Carbon Adsorption

The Phase 2 Treatment System incorporates liquid phase GAC adsorption to remove carbon tetrachloride from the groundwater. Carbon tetrachloride is the only compound detected in the groundwater that is not amenable to biological or UV/oxidation treatment. GAC is a proven method for removal of carbon tetrachloride. The GAC will also serve as a second barrier for VOCs in the unlikely event that these compounds are present in the UV/oxidation system effluent.

The GAC system is positioned at the end of the treatment train to maximize the utilization of the destructive unit operations upstream, and to minimize the use of GAC. This approach will minimize the frequency of GAC bed replacement and the associated cost. Placement downstream from the multimedia filters will also protect the GAC adsorbers from fouling due to suspended solids in the groundwater.

5.2.5 Disinfection

The Phase 2 Treatment System will include disinfection for a small portion (5 gpm) of the total flow to establish chlorine dose and required contact time, and quantify the formation of DBPs. The remainder of the flow will be discharged directly to the Walnut Creek Wash Flood Control Channel without disinfection. A full-scale disinfection system will be constructed if a potable water permit is obtained for the system. The disinfection system will utilize sodium hypochlorite to introduce chlorine into the treated water. Disinfection contact time will be provided by a long pipe arranged in a serpentine fashion. A study of the disinfection system will be performed as part of the operation of the system prior to application for a permit for potable use of the treated water. The study will include quantification of chlorine dose, chlorine contact time, CT_{10} calculation, chlorine residual concentration, and DBP formation in the disinfection system. Microbial water quality will also be evaluated to determine if the optimum disinfectant concentration is controlled by CT requirements or by microbial water quality.

5.3 Multi-Barrier Treatment System

The treatment train for the Phase 2 system is designed to provide a multi-barrier system for both chemical and biological contaminants. For 1,4-dioxane and VOCs, with the exception of carbon tetrachloride, the use of UV/oxidation and GAC provide two distinct barriers. While GAC is not an ideal treatment for 1,4-dioxane, it is adsorbable to a degree. Carbon tetrachloride is not effectively treated with UV/oxidation, but can be removed reliably with GAC. Nitrate and perchlorate are essentially treated only in the bioreactor, although perchlorate is slightly amenable to GAC treatment. The multi-barrier treatment for biological contaminants such as Giardia and cryptosporidium cysts includes removal by filtration in the multimedia filters, deactivation via UV/oxidation, and deactivation in the disinfection system.

5.4 Detailed Design

Detailed design of the treatment system will include sizing of pumps, tanks, piping, and other equipment, selection of materials for construction of piping and equipment, design of concrete structures and foundations, design of power supply and instrumentation and control systems, and a constructability review. The design package will consist of a set of detailed drawings and specifications, and a detailed construction schedule. The design documents will be provided to the appropriate regulatory agencies for review. A preliminary list of drawings and specifications to be prepared during detailed design is provided in Appendix A.

6.0 TREATMENT EQUIPMENT DESCRIPTION

This section presents preliminary design criteria and descriptions for each unit process in the Phase 2 Treatment System including the extraction well, GAC/FB bioreactor, multimedia filters, UV/oxidation system, GAC contactors, disinfection system, reclamation system, flow equalization tanks and transfer pumps, and vapor-phase GAC treatment. Preliminary design criteria for each unit process are presented in Table 6.1. Final design criteria will be developed during detailed design of the Treatment System. Anticipated influent water quality for the system is presented in Table 6.2.

6.1 Extraction Well

The LPVCWD Well No. 2 will be used as the extraction well for the treatment system. This well is located on the same property as the proposed location of the treatment system. The existing pump installed in Well No. 2 can be operated at flow rates ranging from 500 to 1,200 gpm. Since the treatment system will occasionally require that influent flow rates be lower than 500 gpm, a smaller pump motor will be installed with a variable frequency drive to control the treatment system influent flow rate. The design flow rate for the system will be 500 gpm.

6.2 Influent Water Flow Control

The extraction well pump flow rate will be controlled by an inline flow meter and variable frequency drive. Both the influent flow and the bioreactor recycle flow will be routed through fluidization pumps. The fluidization pumps will be controlled by an inline flow meter and control valve. Based on manufacturers' recommendations, reverse flow in the bioreactor should be avoided to prevent GAC fines from clogging the distribution nozzles. The manufacturer has developed a backflow prevention system for the bioreactor to ensure that flow in the bioreactor will not reverse.

6.3 GAC/FB Bioreactors

One GAC/FB bioreactor will be constructed. The stainless steel cylindrical reactor has been preliminarily sized at 8-feet in diameter and approximately 22 feet tall. The reactor will utilize a fluidized bed depth of 15 feet based on the Phase I Treatability Study. Recycle percentages ranging from 0 percent to 100 percent will be evaluated during pilot testing. The surface overflow rate will be set at approximately 13 gpm/ft^2 as recommended by the manufacturer to provide adequate fluidization of the medium. The corresponding empty bed contact time (EBCT) will be 11 minutes. Bioreactor performance will be evaluated based primarily on influent and effluent nitrate and perchlorate concentrations and turbidity. Parameters such as pH, ORP, DO, and TOC will be monitored and used to adjust operating parameters (e.g. recycle rate). Biological parameters such as microorganism concentration, substrate utilization rate, F/M ratio, and mean cell residence time will be evaluated. Microorganism concentration will be estimated by taking representative grab samples from the reactor, shearing the biomass from the GAC in the samples, and measuring the suspended solids. Mean cell residence time will be estimated using suspended solids measurements in the biomass waste line and bioreactor effluent line.

A biogrowth control system will be used to control the fluidized bed depth and the amount of biomass in the reactor. As biomass accumulates on the GAC particles, the fluidized bed height will increase. To control the fluidized bed level, the biogrowth control system, consisting of a growth control cone and a submersible centrifugal pump set at the desired level, will shear excess biomass from the GAC. Buoyant biomass-coated GAC will collect in the growth control cone and be pulled into the suction port on the centrifugal pump. The pumping action will shear excess biomass, and both the sheared biomass and the "clean" GAC particles will be returned to the growth control cone. The "clean" GAC, which is less buoyant than the biomass-coated GAC, will sink toward the bottom of the reactor to provide growth sites for new biomass. The sheared biomass will float to the top of the growth control cone and be removed in a separate biomass waste line. The waste biomass will be discharged to the reclamation system holding tank for treatment in the reclamation system. Collecting waste biomass separately will result in a less turbid reactor effluent and extend the multimedia filter run time.

Ethanol and phosphoric acid will be added to the groundwater upstream of the bioreactor. The ethanol feed system has been preliminarily sized to provide a maximum dosage of 30 mg/l based on the Phase 1 Treatability Study and stoichiometric estimates. Actual ethanol dosage is expected to be 15-20 mg/l. Initially, ethanol dosage will be controlled manually until it can be demonstrated that ORP probes can effectively and reliably control the dosage. ORP probes will be installed at several locations in the bioreactor system to monitor changes and correlate influent and effluent ethanol concentrations and nitrate and perchlorate destruction efficiencies. The ORP probes will be equipped with data loggers. Once a correlation has been established, the ORP controller output will be adjusted to minimize the effluent ethanol concentration while still achieving required perchlorate and nitrate removals. The phosphoric acid feed system has been preliminarily sized to provide a maximum phosphorous dosage of 0.3 mg/l. Optimum phosphorous dosage will be determined during pilot testing according to residual phosphorous concentrations in the bioreactor effluent.

Biological solids production has been preliminarily estimated based on a sludge yield factor of 0.8 mg of volatile suspended solids (VSS) created per mg of nitrate-nitrogen reduced in the bioreactor (Metcalf & Eddy, 1991). Assuming an influent nitrate-nitrogen concentration of 5 to 7 mg/l, approximately 29 pounds (range of 25 to 35 pounds) of VSS will be produced per day. The VSS will be transported to the reclamation system via the biomass waste line, in the filter backwash water, or in the filter-to-waste water.

Oxygen will be added to the bioreactor effluent in a post-aeration basin upstream of the multimedia filters, which will be operated in a biologically active mode. This will allow the biomass in the filters to consume remaining ethanol and breakdown products in the bioreactor effluent. The basin is preliminarily sized to increase the DO concentration from 0 mg/l to approximately 5 mg/l using fine bubble diffusers. The oxygen demand in the bioreactor effluent is expected to be less than 1 mg/l. Optimum DO concentration will be assessed during pilot testing. While the main objective of the post-aeration basin is to add oxygen, some stripping of VOCs may take place. Therefore, the discharge air from the basin will be collected in a hood and passed through a vapor-phase GAC contactor. During pilot testing, operation of the post-aeration basin will be adjusted to minimize the amount of VOC stripping that occurs.

6.4 Multimedia Filters

Two multimedia filters will be constructed to filter the bioreactor effluent and consume any remaining ethanol. The filters have been preliminarily sized at 10 feet long, 6.5 feet wide, and approximately 12 feet tall. The bed will consist of anthracite, sand and garnet with a total bed depth of 2.6 feet. Surface loading rates ranging from 4 to 8 gpm/ft^2 will be evaluated during pilot testing. If a loading rate greater than 6 gpm/ft^2 proves to be optimum, approval of the higher loading rate will be sought pursuant to Title 22 regulations. Effluent turbidity (via inline turbidimeters), pathogen removal, and effluent ethanol concentration will be used to evaluate filter performance. Filtered water quality will also be evaluated using inline particle counters on both the influent and effluent lines. The filters will be designed for constant-rate loading. The multimedia filters will be constructed of concrete.

Polymer will be added prior to the multimedia filters as a filter aid. The polymer feed system has been preliminarily sized for a maximum dosage of 1 mg/l. Optimum polymer dosage will be assessed during pilot testing. The polymer will be mixed using an inline static mixer to promote coagulation. The need for flocculation is not anticipated for this application to meet the Title 22 requirements. Results from the pilot testing will be used to demonstrate that this treatment train meets the Title 22 performance standards for filtration.

The multimedia filters will be backwashed using a combination of air and water. The backwash system has been preliminarily sized using a water overflow rate of 10 gpm/ft^2 and an air flow rate of 3 standard cubic feet per minute per square foot (scfm/ft^2). Backwash time will be optimized using backwash turbidimeters to ensure the maintenance of established microbial population subsequent to backwash events. Filter run times have been preliminarily estimated to be at least 24 hours. Actual filter run time will be determined during pilot testing based on head loss across the filter. Clean backwash water will be collected from the main process stream at a point prior to disinfection and stored in a separate holding tank. Collecting clean backwash water prior to disinfection is required to ensure that the filters remain biologically active. Spent backwash water will be discharged to the reclamation system holding tank for treatment in the reclamation system.

A filter-to-waste system will be utilized following each filter backwash. Filter effluent immediately following a backwash event will be discharged to the reclamation system holding tank for treatment in the reclamation system. Optimum filter-to-waste time will be determined during pilot testing based on measurement of filter effluent turbidity following backwash.

6.5 UV/Oxidation System

One UV/oxidation System will be installed to remove VOCs, NDMA, and 1,4-dioxane. The UV system has been preliminarily sized to provide a total of 90 kilowatts (kW) of UV power based on anticipated influent concentrations of VOCs, NDMA, and 1,4-dioxane. Optimum UV power will be determined during pilot testing. Influent and effluent concentrations of VOCs, NDMA, and 1,4-dioxane will be used to evaluate the UV/oxidation system performance.

Hydrogen peroxide will be used as the oxidant for the UV system and injected prior to the UV unit. The hydrogen peroxide feed system has been preliminarily sized for a dosage of 25 mg/l. Optimum dosage will be determined during pilot testing.

6.6 GAC Contactors

Two GAC contactors (operated in series) will be installed to remove carbon tetrachloride and act as a final polishing unit. The GAC contactors have been preliminarily sized for a surface loading rate of 6.4 gpm/ft^2, resulting in a 10-foot-diameter cylindrical contactor. Each contactor will contain approximately 20,000 lbs of GAC with a bed depth of 8.5 feet and have an EBCT of 10 minutes (20 minutes total for two contactors in series). The GAC bed life has been preliminarily estimated at 500 to 700 days based on the expected carbon tetrachloride concentration. The GAC contactors will be rubber-lined pressure vessels with stainless steel distribution piping.

6.7 Disinfection System

Sodium hypochlorite will be used as the disinfectant for the Pilot System and injected into the GAC effluent, mixed using a static mixer, routed through a long pipe arranged in a serpentine fashion to provide contact time, and discharged to the Walnut Creek Wash Flood Control Channel adjacent to the site. During pilot testing, only a portion of the flow (5 gpm) will be disinfected. A peristaltic feed pump will be used during pilot testing to provide a continuous flow of sodium hypochlorite. A disinfection system capable of treating the full flow will be constructed if a potable water permit is obtained for the system. The sodium hypochlorite feed system has been preliminarily sized for a chlorine dose of 3 mg/l. Optimum chlorine dose will be determined during pilot testing based on CT requirements and microbial water quality. Formation of DBPs will also be monitored during pilot testing. Depending on the results of sodium hypochlorite testing, a chloramination system may also be tested.

6.8 Reclamation System

A reclamation system will be constructed to treat backwash water and filter-to-waste water from the multimedia filters and waste biomass from the GAC/FB bioreactors. The reclamation system will consist a lamella clarifier and a filter press. Average flow to the reclamation system has been preliminarily estimated at 41 gpm based on filter backwash and filter-to-waste assumptions and assuming that 2 percent of the bioreactor flow is discharged as waste biomass. The lamella clarifier has been preliminarily sized for a surface overflow rate of 0.5 gpm/ft^2. Reclaimed water will be returned to the main flow stream prior to the multimedia filters.

Ferric chloride, ferric sulfate and aluminum sulfate (alum) will be evaluated as coagulants for the reclamation system. A high molecular weight cationic emulsion polymer will also be evaluated. Coagulant dose is preliminarily estimated at 30 mg/l, approximately 50% (by weight) of the biological solids production. The optimum coagulant and coagulant dose will be determined during pilot testing.

Clarifier solids production is preliminarily estimated at approximately 44 pounds of dry solids per day based on biological solids production and coagulant dose. Based on an estimated clarifier sludge solids content of 2 percent, approximately 260 gallons of clarifier solids will be produced per day. A filter press will be used to further concentrate the clarifier sludge to approximately 30 percent solids. This will result in approximately 150 pounds of wet sludge produced per day. This sludge will be disposed off-site at an appropriate land disposal facility.

6.9 Flow Equalization Tanks and Transfer Pumps

Flow equalization will be required at two locations in the treatment train; between the multimedia filters and UV/oxidation system, and between the GAC contactors and the disinfection system. The tanks have been preliminarily sized for a holding time of 15 minutes, resulting in a tank volume of 15,000 gallons. Two variable speed, centrifugal transfer pumps will used to transfer water from each equalization tank to the next downstream treatment unit. Level sensors and controllers in the equalization tanks will be used to control the variable speed drives.

6.10 Vapor-Phase GAC Treatment

Vapors will be collected from the GAC/FB bioreactor, media separator, aeration tank, multimedia filters, equalization tank, and reclamation tank (all of which will be covered) and passed through a vapor-phase GAC contactor. The existing air stripper vapor-phase GAC contactors at the site will be evaluated during final design to determine if one of them can be used for this purpose. If so, the existing GAC in the contactor will be replaced with new GAC prior to start-up of the pilot system. If not, a new vapor-phase GAC contactor will be installed. Air emissions monitoring and testing will be performed as required on the influent and effluent air streams of the vapor-phase GAC contactor.

Table 6.1: Preliminary Phase 2 Pilot System Design Criteria

Description	Value	Unit
Extraction Well		
Flow Rate	500	gpm
GAC/FB Bioreactor		
Bioreactor		
Recycle Ratio (Recycle Flow : Influent Flow)	0.30	
Total Bioreactor Flow Rate	650	gpm
Overflow Rate	13	gpm/ft^2
Number of Reactors	1	
Surface Area/Reactor	50.0	ft^2
Reactor Diameter	8.0	ft
Fluidized Bed Depth	15	ft
Fluidized Bed Volume	955	ft^3
Empty Bed Contact Time	11.0	minutes
Ethanol Feed System		
Ethanol Dose	30	mg/l
Mass Loading	180	lb/day
Ethanol Density	6.67	lb/gal
Volumetric Loading	27	gal/day
Feed Tank Holding Time	15	days
Feed Tank Volume	405	gal
Total Number of Feed Pumps	2	
Number of Feed Pumps Operating	1	
Feed Pump Flow Rate	27	gal/day
Phosphoric Acid Feed System		
Phosphoric Acid Dose (as H_3PO_4)	1	mg/l
Phosphorous Dose (as P)	0.32	mg/l
Mass Loading	6	lb/day
Percent Phosphoric Acid by Weight	50%	
Phosphoric Acid (85%) Density	14.1	lb/gal
Volumetric Loading	0.85	gal/day
Feed Tank Holding Time	30	days
Feed Tank Volume	26	gal
Total Number of Feed Pumps	2	
Number of Feed Pumps Operating	1	
Feed Pump Flow Rate	0.85	gal/day

Table 6.1: Preliminary Phase 2 Pilot System Design Criteria

Description	Value	Unit
Biomass Control System		
Submersible Centrifugal Pump	per	manufacturer
Growth Control Cone	per	manufacturer
Sludge Yield Factor (by weight)	0.8	VSS/NO_3^--N
Nitrate-N Influent Concentration	6	mg/l
Biological Solids Production (as VSS)	28.8	lb/day
Waste Biomass Flow Percentage	2%	of influent flow
Waste Biomass Flow Rate	10.0	gpm
Percent of Biological Solids in Waste Biomass Line	90%	
Waste Biomass VSS concentration	216.0	mg/l
Aeration Blower		
Oxygen Dose	5	mg/l
Mass Oxygen Loading	30.0	lb/day
Density of Air @ STP	0.076	lb/cf
Percent of Oxygen	20%	
Oxygen Transfer Efficiency	50%	
Air Flow Rate	2.7	scfm
Multimedia Filters		
Filters		
Type: Constant Rate		
Loading Rate	4	gpm/ft^2
Flow Rate to Filters (Influent - Waste Biomass + Reclamation)	531.4	gpm
Number of Filters	2	
Surface Area/Filter	66.4	ft^2
Length	10.0	ft
Width	6.6	ft
Anthracite Layer Depth	16.5	in
Sand Layer Depth	10	in
Garnet Sand Layer Depth	4.5	in
Bed Depth	2.6	ft
Garnet Gravel Layer Depth (support gravel)	3	in
Graded Gravel Layer Depth (support gravel)	3	in
Polymer Feed System		
Polymer Dose	1	mg/l
Mass Loading	6.0	lbs/day
Hopper Holding Time	31	days
Hopper Size	186	lbs
Mix Ratio by Weight	1%	
Volumetric Loading Rate	72	gal/day

Table 6.1: Preliminary Phase 2 Pilot System Design Criteria

Description	Value	Unit
Mix/Feed Tank Holding Time	15	days
Mix/Feed Tank Volume	1,080	gal
Total Number of Feed Pumps	2	
Number of Feed Pumps Operating	1	
Feed Pump Flow Rate	72	gal/day
Backwash System		
Type: Combined Air and Water		
Water Overflow Rate	20	gpm/ft^2
Air Loading Rate	3	$scfm/ft^2$
Backwash Flow Rate	1,328	gpm
Air Flow Rate	199	scfm
Total Number of Backwash Pumps	2	
Number of Backwash Pumps Operating	1	
Backwash Pump Flow Rate	1,328	gpm
Backwash Time/Filter	15	minutes
Backwash Volume/Filter	19,926	gal
Backwash Frequency/Filter	1	days
Clean Backwash Water Storage Tank Volume (1 Filter + 20%)	23,911	gal
Estimated Filter-to-Waste Time/Filter	10	minutes
Filter-to-Waste Volume/Filter	2,657	gal
UV/Oxidation System		
UV/Oxidation System		
Number of Units	1	
Total UV Power	90	kW
Peroxide Feed System		
Peroxide Dose	25	mg/l
Mass Loading	150	lb/day
Percent Peroxide by Weight	50%	
Peroxide (50%) Density	8.34	lb/gal
Volumetric Loading	36	gal/day
Feed Tank Holding Time	15	days
Feed Tank Volume	540	gal
Total Number of Feed Pumps	2	
Number of Feed Pumps Operating	1	
Feed Pump Flow Rate	36	gal/day

Table 6.1: Preliminary Phase 2 Pilot System Design Criteria

Description	Value	Unit
GAC Contactors		
Contactors		
Loading Rate	6.4	gpm/ft^2
Total Number of Contactor Trains (1 Train = 2 Contactors in Series)	1	
Number of Contactor Trains Operating	1	
Surface Area/Contactor	78.1	ft^2
Contactor Diameter	10.0	ft
Weight of GAC/Contactor	20,000	lbs
Density of GAC	30	lb/ft^3
Volume of GAC/Contactor	667	ft^3
GAC Bed Depth	8.5	ft
Empty Bed Contact Time (for both contactors)	20	minutes
Estimated Bed Life (based on 5 ug/l CCl_4)	500	days
Disinfection System		
Sodium Hypochlorite Feed System		
Disinfection System Flow Rate	5	gpm
Chlorine Dose	3	mg/l
Chlorine Mass Loading	0.2	lb/day
Available Chlorine	1.0%	
Sodium Hypochlorite Mass Loading	18.0	lb/day
Sodium Hypochlorite Density	8.34	lb/gal
Sodium Hypochlorite Volumetric Loading	2.2	gal/day
Feed Tank Holding Time	7	days
Feed Tank Volume	15	gal
Number of Feed Pumps	1	
Feed Pump Flow Rate	2.16	gal/day
Chlorine Contact Piping		
Pipe Diameter	6	inches
Velocity	0.06	ft/s
Contact Time	20	minutes
Pipe Length	68	feet

Table 6.1: Preliminary Phase 2 Pilot System Design Criteria

Description	Value	Unit
Reclamation System		
Reclamation System Equalization Tank		
Equalization Tank Volume (1.5 Filter Backwash Volumes)	29,889	gallons
Feed Pumps & Return Pumps		
Average Flow to Reclamation System	41.4	gpm
Total Number of Feed Pumps	2	
Number of Feed Pumps Operating	1	
Feed Pump Flow Rate	41.4	gpm
Coagulant Feed System		
Coagulant Dose	30	mg/l
Mass Loading	14.9	lb/day
Coagulant Density	10.8	lb/gal
Volumetric Loading	1.4	gal/day
Feed Tank Holding Time	15	days
Feed Tank Volume	21	gal
Total Number of Feed Pumps	2	
Number of Feed Pumps Operating	1	
Feed Pump Flow Rate	1.4	gal/day
Clarifier		
Type: Lamella		
Total Dry Solids Production (Biological + Coagulant)	43.7	lb/day
Clarifier Sludge Percent Solids	2%	
Clarifier Sludge Production	262	gal/day
Sludge Holding Tank		
Holding Time	2.0	days
Volume	524	gallons
Filter Press		
Type: Recessed Plate		
Filter Sludge Percent Solids	30%	
Filter Cake Production (as wet solids)	146	lbs/day
Filter Cake Density	70	lb/ft^3
Filter Cycles per Day	1	cycles/day
Filter Press Size	2.1	ft^3

Table 6.1: Preliminary Phase 2 Pilot System Design Criteria

Description	Value	Unit
Flow Equalization Tanks and Transfer Pumps		
Equalization Tanks		
Tank Holding Time	45	minutes
Tank Volume	22,500	gal
Transfer Pumps		
Type: Variable Speed		
Total Number of Pumps	3	
Number of Pumps Operating	2	
Pump Flow Rate	250	gpm

Table 6.2: Anticipated Pilot System Influent Water Quality

Analyte	Value
VOCs	
Trichloroethylene (1,1,2-Trichloroethene)	67.8
1,2-Dichloroethane (Ethylene Dichloride)	5.0
Carbon Tetrachloride (Tetrachloromethane)	3.9
Tetrachloroethene (Perchloroethylene)	3.5
Dichlorodifluoromethane (Fluorocarbon-12)	2.8
Chloroform (Trichloromethane)	2.7
cis-1,2-Dichloroethylene	1.2
1,1-Dichloroethylene	0.6
Total VOCs	**87.5**
Other Analytes	
Nitrate-N (mg/l)	5.6
Perchlorate (ClO4-)	141.5
N-Nitrosodimethylamine (NDMA)	0.9
1,4-Dioxane	1.5
Total Trihalomethanes (TTHM)	2.5

Notes:
All values in µg/l unless otherwise noted
Sampling results from LPVCWD Wells 02 and 03
Values are average for samples taken on 2/6/98 and 6/11/98
Only analytes with concentrations above detection limit shown
All other analytes tested had concentrations below detection limit

7.0 PERMITTING

A number of permits must be obtained to build and operate the Phase 2 Treatment System. Some of these permits must be secured prior to start of construction, others are needed before system startup, and others are needed before the system effluent can be introduced into the potable water supply. Some of the key permitting requirements are described below.

7.1 Construction Permits

All construction permits normally required from state and local agencies will be obtained once facility design has been completed.

7.2 Discharge Permit

The Phase 2 Treatment System will discharge treated water to the Walnut Creek Wash Flood Control Channel adjacent to the site. The LPVCWD already has a Walnut Creek discharge point and the Watermaster holds a discharge permit. The Watermaster will amend this permit or obtain a new permit from the Los Angeles Regional Water Quality Control Board for discharge of treated water from the system. The permitting process has been initiated. The modified discharge permit must be secured before system startup.

7.3 Ethanol Permit

To secure denatured alcohol in the volumes required to support bioreactor operation, a permit from Alcohol, Tobacco, and Firearms (ATF) is required. The permit application has been submitted to ATF. This permit will be secured before system startup.

7.4 Certification of Additives

All chemicals used in a public water supply must be produced by a manufacturer certified to produce those chemicals or be "food grade". All proposed additives for the treatment system appear to be available in food grade. If certification is necessary, two entities can perform this certification:

Underwriters Laboratories (UL) and the National Sanitation Foundation (NSF). Initial chemical sourcing and certification procedures have been initiated. This permit will not be needed until a potable water operating permit is obtained from DHS and treated water is introduced to the potable water supply.

7.5 DHS Operating Permit

An operating permit must be obtained from DHS in order for the Phase 2 Treatment System to introduce water into the potable water supply. Securing this permit is the ultimate goal for the Phase 2 Treatability Study and many of the planned activities, monitoring, and data interpretation will be performed to establish the level of confidence necessary for DHS to issue an operating permit.

The source of water used for the Phase 2 Treatment System (BPOU groundwater) is considered an Extremely Impaired Source by DHS due to the contaminants present in the water and their concentrations. As outlined in the DHS Policy Memo 97-005, "Policy Guidance for Direct Domestic Use of Extremely Impaired Sources", the following elements are required for evaluation of an operating permit:

- Source water assessment including:
  - Delineation of the source water capture zone
  - Identification of contaminant sources
- Full characterization of the raw water quality including:
  - Title 22 drinking water regulated and unregulated chemicals
  - All chemicals for which drinking water action levels are established
  - All chemicals listed pursuant to the Safe Drinking Water and Toxic Enforcement Act of 1986
  - Microbiological quality
  - Priority pollutants
  - Gross contaminant measures [total organic carbon (TOC), etc.]
  - Any compounds identified under source water assessment

- Variability of contaminant concentrations with time (seasonal and long term)
- Variability of contaminant concentrations with pumping rate
- Inclusion of any contaminant identified during characterization in the source water assessment

- Source protection program including:
  - Prevention of rising contaminant levels
  - Minimization of dependence on treatment
- Effective monitoring and treatment including:
  - Performance standards
  - Operations plan
  - Reliability features
  - Compliance monitoring and reporting program
  - Notification plan
  - Extremely impaired source water quality surveillance plan
- Human health risks associated with failure of proposed treatment including:
  - Evaluation of the risks of failure of the propose treatment system
  - Assessment of the potential health risks associated with failure of the proposed treatment system
- Identification of alternatives to the use of the extremely impaired source including:
  - Comparison of potential health risk associated with alternative sources to proposed source
  - Comparison of the risks of treatment failure for the alternative sources to proposed source
  - Completion of the California Environmental Quality Act (CEQA) review of the project
  - Submittal of the permit application
  - Public hearing
  - DHS evaluation

The following two findings are required for DHS to approve the use of an extremely impaired source:

- Drinking water MCLs and Action Levels (ALs) will not be exceeded if the permit is complied with
- The potential for human health risk is minimized, and the risk associated with the project is less than or equal to the alternatives

Each of the above elements will be prepared during operation of the Phase 2 Treatment System and a permit application will be submitted to DHS at the conclusion of the Phase 2 Treatability Study.

8.0 OPERATION AND MAINTENANCE MANUAL

Prior to startup of the Treatment System, an O&M Manual will be prepared. The O&M Manual will contain the following elements:

- Detailed description of each individual process within the overall treatment system, including major equipment components, associated instrumentation and controls, and relationships with the other processes.
- Detailed instructions for operation of each unit operation within the system, including startup, routine and emergency operations, shutdown, troubleshooting, and general maintenance.
- A description of the control system operation, configuration of graphical interface screens, and instructions for acknowledging alarms and setting system parameters.
- Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) described below.
- Record-keeping requirements.
- Health and safety plan (HSP) which describes physical and chemical hazards, requirements for protective clothing, sign-in procedures, emergency response procedures, and contains material safety data sheets (MSDSs) for all chemicals stored onsite. This document will govern all activities at the site during startup and operations and will apply to all personnel working on or visiting the site.
- Compendium of product literature, including manufacturer's installation, operating, and maintenance instructions for all major equipment, and data sheets for all instruments.

The SAP will include:

- Detailed sampling procedures for each category of analytes.
- Location and frequency of sample collection.
- Analytes and analytical methods for each sample.
- A communications plan with provisions for reporting project status to EPA.
- Development of focused sampling programs for specific objectives including: study of DBP formation; demonstration of the efficacy of an alternative filtration technology under the surface water treatment rule; development of criteria for "steady state" operation of the bioreactor; study of the potential for biological regrowth in the distribution system; confirmation of acceptable bacterial and pathogen removal in product water, and confirmation of acceptable taste, color, and odor of the product water.
- Development of acceptable analytical methods and detection limits for analytes such as ethanol and carboxylic acids.

- QAPP which will include development of data quality objectives (DQOs) and will specify the type and frequency of quality control samples such as blanks and duplicates.

A preliminary list of analytes and analytical methods is provided in Table 8-1. A preliminary table of contents for the O&M Manual is provided below.

OPERATION AND MAINTENANCE MANUAL
Baldwin Park Operable Unit
Pilot-Scale Groundwater Treatment System

Preliminary Table of Contents

Appendixes

Table 8-1: Preliminary Summary of Analytes and Methods

Analytes	EPA Method	Preservative	Holding Time	Sample Container	Sample Volume	Method Detection Limit	Reporting Limit
Primary and Secondary Title 22 Analytes	Varied	Varied	Varied	Varied	Varied	Varied	Varied
Volatile Organic Compounds, DBPs, 1,4-Dioxane , Acetone, Methyl Ethyl Ketone	8260	HCL-pH<2	14 days	40 ml VOA	3 x 40 ml	Varied	5 - 100 µg/l
Ethanol, Formaldehyde, Acetaldehyde	8015 (modified)	4°C	14 days	40 ml VOA	1 x 40 ml	To be determined	
Formic Acid, Propionic Acid	GC/MS	HCl ~ph<2	14 days	40 ml VOA	3 x 40 ml	To be determined	
Perchlorate	300 (modified)	4°C	14 days	Poly	125 ml	2 ppb	5 ppb
Chlorate, Chlorite, Hypochlorite	300	4°C	14 days	Poly	100 ml	To be determined	200,20,50 ppb
Nitrosodimethylamine	8270	4°C	14 days	1L Amber	1,000 ml	To be determined	
Alkalinity (carbonate/bicarbonate)	310.1	4°C	14 days	Poly	500 ml	---	5 mg/l ppm
Chloride	325.2	4°C	28 days	Poly	50 ml	0.72 ppb	1.0 mg/l ppm
Total Phosphorus	365.5	H_2SO_4	28 days	Poly	100 ml	0.04 ppb	0.3 mg/l ppm
Nitrogen, Ammonia	350.1	H_2SO_4	28 days	Poly	100 ml	0.027 ppb	0.1 mg/l ppm
Nitrogen, Nitrate, Nitrite	353.1	4°C	28 days	Poly	100 ml	0.0044 ppb	0.1 mg/l ppm
Sulfate, Sulfide	375.4	Cool 4°C	Sulfate - 28 days Sulfide - 7 days	Poly	100 ml	---	1.0 mg/l ppm
Metals*	6000/7000	HNO_2 - pH<2	6 months	Poly	500 ml	Varied	Varied
Bacteriology#	9200	Sodium Thiosulfate 4°C	24 hours	Plastic	100 ml	Varied	Varied
Giardia and Cryptosporidium	IFA/1622						
Viruses							
Total Dissolved Solids	160.1	4°C	7 days	Poly	100 ml	---	10 mg/l ppm
Total Suspended Solids	160.2	4°C	7 days	Poly	500 ml	---	5 mg/l ppm
Turbidity	180.1	4°C	2 days	Poly	50 ml	---	1 NTU
Color	110.2	4°C	2 days	Poly	500 ml		
Total Organic Carbon	9060	4°C	2 days	1L Amber	1,000 ml		
AOC/BDOC							
Biochemical Oxygen Demand	405.1	4°C	2 days	1L Amber	1,000 ml	---	3.0 mg/l
Chemical Oxygen Demand	410.4	HNO_2 - pH<2	28 days	Poly	50 ml	8.9 ppb	10 mg/L
UV254 Absorption							

µg/l Micrograms per liter
mg/l Milligrams per liter
ml Milliliter
Poly Polyethylene

Table 8-1 (continued)

ppb	Parts per billion
ppm	Parts per million
VOA	Volatile organic analyte
IFA	Indirect fluorescent antibody test
AOC	Assimilable organic carbon
BDOC	Biodegradable organic carbon

* Title 22 metals, potassium, sodium, magnesium, iron, calcium, manganese

\# Total and fecal coliform and heterotrophic plate count

9.0 REFERENCES

Harding Lawson Associates. 1997a. *Draft final, Phase 1 Treatability Study, Baldwin Park Operable Unit, San Gabriel Basin.*

——. 1997b. *Distribution and Treatability of Perchlorate in Groundwater, Baldwin Park Operable Unit, San Gabriel Basin.*

——. 1997c. *Final Addendum to Sampling and Analysis Plan, Pre-remedial Design Groundwater Monitoring Program, Baldwin Park Operable Unit, San Gabriel Basin.*

——. 1998. *Draft Phase 2A Monitoring Well Installation and Groundwater Sampling Report, Baldwin Park Operable Unit, San Gabriel Basin.*

McCarty, P.L., L. Beck, and P. St. Amant. 1969. Biological denitrification of wastewaters by addition of organic materials. *Proceedings of the 24th Purdue Industrial Waste Conference,* Lafayette, Indiana.

Metcalf & Eddy. 1991. *Wastewater Engineering.* 3rd Ed. McGraw Hill

Appendix A

PRELIMINARY DRAWING LIST
AND
PRELIMINARY LIST OF SPECIFICATIONS

Preliminary Drawing List
Baldwin Park Operable Unit – Biotreatment
San Gabriel Basin, California

DRAWINGS

Sheet Number	Drawing Number	Description
		GENERAL
1	A-1	Cover Sheet
2	A-2	Sheet List, General Notes, Legend
		YARD WORK
3	Y-1	Site Plan
4	Y-2	Site Buried Piping Plan 1
5	Y-3	Site Buried Piping Plan 2
6	Y-4	Site Buried Piping Details
7	Y-5	Sewer Line Plan and Profile
8	Y-6	Sewer Line Details
9	Y-7	Miscellaneous Details
		PRE-ENGINEERED BUILDINGS
10	B-1	Control Building Foundation Plan, Floor Plan, and Details
11	B-2	Control Building Elevations and Details
12	B-3	Reclamation and Bioreactor Pad Sunshade Plan and Details
		RECLAMATION PAD
13	RP-1	General Arrangement Plan
14	RP-2	Reclamation Pad Foundation Plan
15	RP-3	Chemical Containment Area Structural Plan and Sections
16	RP-4	Reclamation Pad Piping Plan
17	RP-5	Reclamation Pad Piping Details
		MULTI-MEDIA FILTER PAD
18	MF-1	General Arrangement Plan
19	MF-2	Multi Media Filter Plan
20	MF-3	Multi Media Filter Pad Sections 1
21	MF-4	Multi Media Filter Pad Sections 2
22	MF-5	Multi Media Filter Details -1
23	MF-6	Multi Media Filter Details -2
24	MF-7	Vapor Phase GAC System Details

Sheet Number	Drawing Number	Description
25	MF-8	Multi Media Filter Pad Base Slab and Wall Layout Plan
26	MF-9	Multi Media Filter Pad Roof Plan
27	MF-10	Multi Media Filter Pad Typical Corner Joint Details
28	MF-11	Multi Media Filter Pad Typical Concrete Details, Schedules, and Notes
29	MF-12	Multi Media Filter Pad Typical Transverse Section
30	MF-13	Multi Media Filter Pad Typical Longitudinal Section
		BIOREACTOR PAD
31	BR-1	Concrete Layout Plan
32	BR-2	General Arrangement Plan
33	BR-3	Bioreactor, Media Separator, and Fluidization Pumps - Plan and Details
34	BR-4	Bioreactor, Media Separator, and Fluidization Pumps - Details and Sections
35	BR-5	Bioreactor, Media Separator, and Fluidization Pumps - Elevations
36	BR-6	UV/Oxidation System and GAC Contactors Plan and Details
37	BR-7	UV/Oxidation System and GAC Contactors Elevations
38	BR-8	Disinfection System Plan, Details, and Elevations
39	BR-9	Chemical Feed System Plan and Details
40	BR-10	Chemical Feed System Elevations
		GENERAL DETAILS
41	G-1	Process Flow Diagram
42	G-2	Chemical Feed Schematics
43	G-3	Standard Concrete Details
44	G-4	Miscellaneous Details
45	G-5	Miscellaneous Details
		INSTRUMENTATION
46	I-1	Instrumentation and Control Legend
47	I-2	Plant Operation P&ID
48	I-3	Chemical Feed P&ID
		ELECTRICAL
49	E-1	Electrical Abbreviations and Symbols
50	E-2	Site Power Plan
51	E-3	Power and Grounding Layout
52	E-4	Lighting and Receptacles Plan
53	E-5	Instrument and Control Layout
54	E-6	Instrument and Control Layout
55	E-7	Instrument and Control Layout

Sheet Number	Drawing Number	Description
56	E-8	480V Single Line Diagram
57	E-9	Panelboard Schedule
58	E-10	PLC/SCADA System Overview
59	E-11	Panel Layout
60	E-12	Panel Layout
61	E-13	Typical 480V Motor Control Schematic
62	E-14	Typical 120V Metering Pump Control Schematic
63	E-15	Typical Instrument Control Loops

Preliminary Specification List
Baldwin Park Operable Unit
San Gabriel Basin, California

SPECIFICATIONS

DIVISION 1 - GENERAL REQUIREMENTS

Section 01015 – Project Requirements
Section 01300 - Submittals
Section 01400 – Quality Control
Section 01610 – General Equipment Stipulations

DIVISION 2 - SITE WORK

Section 02115 - Site Preparation and Earthwork
Section 02605 – Sewer Manholes
Section 02628 – PVC Sewer Pipe

DIVISION 3 - CONCRETE

Section 03000 – Cast-in-Place Concrete
Section 03600 – Grout

DIVISION 4 - MASONRY

Not used.

DIVISION 5 - METALS

Section 05313 – Steel Form Deck
Section 05550 – Anchor Bolts and Expansion Anchors
Section 05990 – Structural and Miscellaneous Metals

DIVISION 6 - WOOD AND PLASTIC

Not used.

DIVISION 7 - SEALANTS AND CAULKING

Section 07900 - Sealants

DIVISION 8 - DOORS AND WINDOWS

Not used.

DIVISION 9 - PROTECTIVE COATINGS

Section 09900 - Painting

DIVISION 10 - SPECIALTIES

Section 10800 – Toilet Accessories

DIVISION 11 - EQUIPMENT

Section 11211 - Horizontal Centrifugal Pump
Section 11212 - Submersible Sump Pumps
Section 11213 - Air-Operated Diaphragm Pumps
Section 11240 - Chemical Feeding Equipment
Section 11302 – Lamella Clarifier
Section 11360 - Filter Press Equipment
Section 11361 – Filter Press Feed Pumps
Section 11364 – Packaged Rapid Mix, Flocculation, and Settling System
Section 11501 - UV/Chemical Oxidation System
Section 11502 - Liquid-Phase Granular Activated Carbon Adsorbers
Section 11503 - Vapor-Phase Granular Activated Carbon Adsorbers
Section 11505 - Filter Media
Section 11510 – Granular Activated Carbon/Fluidized Bed (GAC/FB) Bioreactor
Section 11999 - Miscellaneous Equipment

DIVISION 12 - FURNISHINGS

Not used.

DIVISION 13 - SPECIAL CONSTRUCTION

Section 13440 - Prefabricated Metal Building

DIVISION 14 - CONVEYANCE SYSTEMS

Not used.

DIVISION 15 - MECHANICAL

Section 15050 - Pipe Systems – General
Section 15100 - Valves
Section 15121 - Eyewash/Emergency Shower

DIVISION 16 - ELECTRICAL

Section 16010 - Basic Electrical Requirements
Section 16111 - Conduit
Section 16120 - Wire and Cable
Section 16130 - Boxes
Section 16140 - Wiring Devices
Section 16195 - Electrical Identification
Section 16450 - Secondary Grounding
Section 16461 - Dry Type Transformers
Section 16470 - Panelboards
Section 16480 - Motor Controls

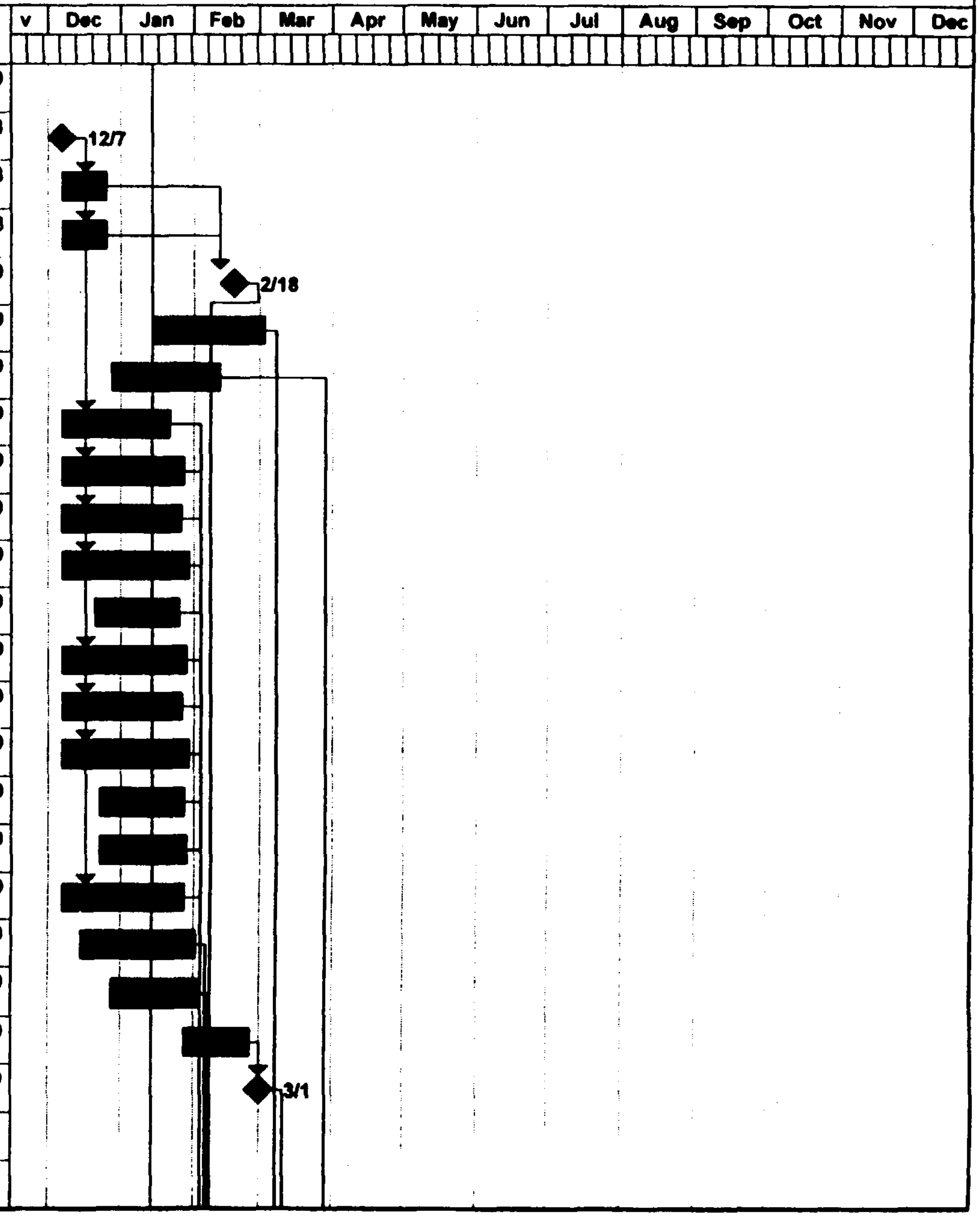
Section 16481 – Variable Frequency Drives
Section 16500 – Lighting
Section 16535 - Emergency Lighting Equipment

Appendix B

PRELIMINARY DESIGN-BUILD PROJECT SCHEDULE

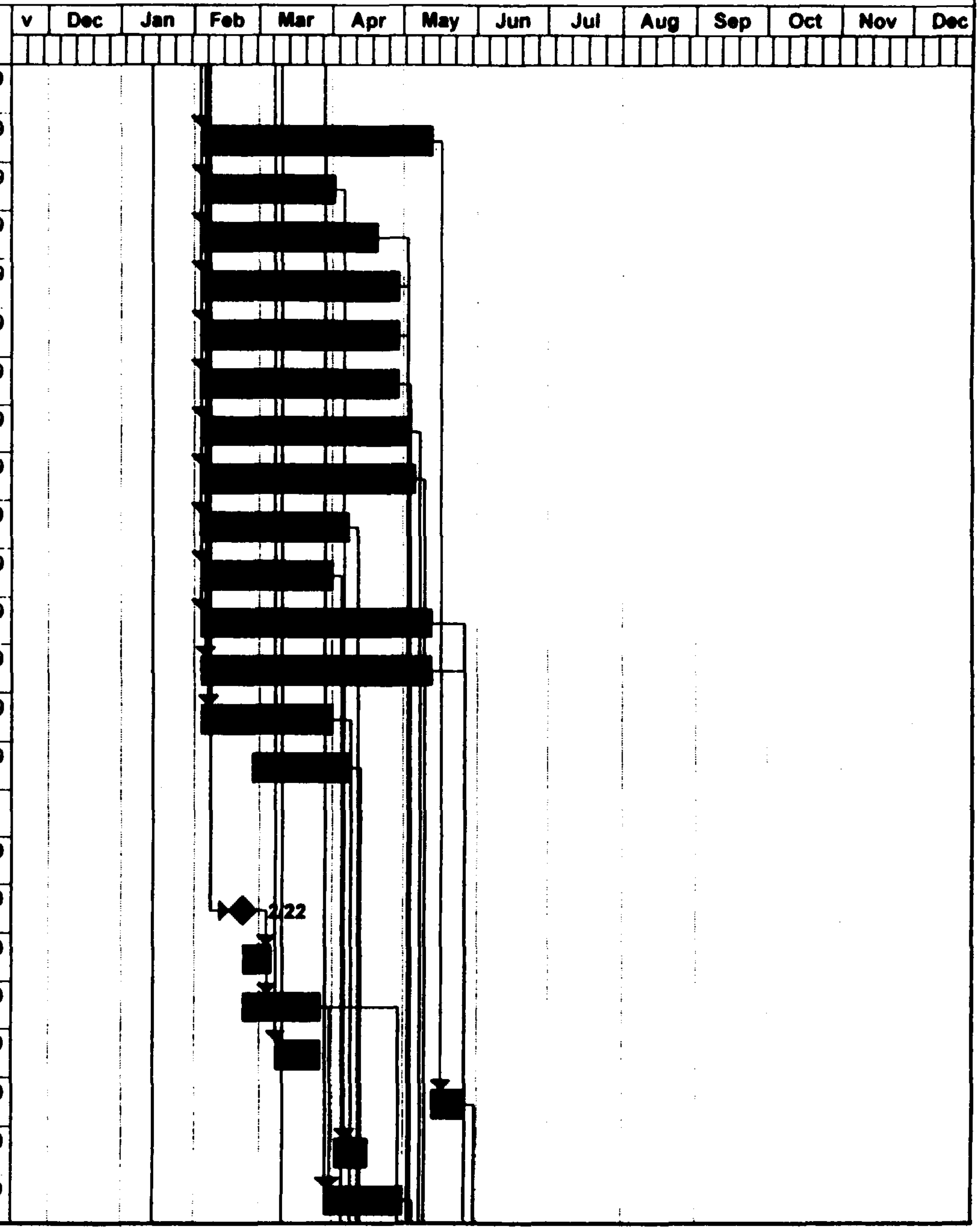
Baldwin Park Operable Unit
Phase 2 Groundwater Treatment System
DESIGN - BUILD PROJECT SCHEDULE

ID	Task Name	Dur	Start	Finish
1	**Design Phase**	62d	12/7/98	3/2/99
2	Coordination Meeting with Stetson	0d	12/7/98	12/7/98
3	Fire Line and Sewer Line Design	15d	12/7/98	12/25/98
4	Foundation and Pad Design	15d	12/7/98	12/25/98
5	Complete Preliminary Drawings	0d	2/18/99	2/18/99
6	Underground Piping Design	33d	1/15/99	3/2/99
7	Multi-Media Filter Structural Design	34d	12/28/98	2/11/99
8	GAC/FB Bioreactor Design	34d	12/7/98	1/21/99
9	UV/Oxidation System Design	38d	12/7/98	1/27/99
10	Multi-Media Filter Design	37d	12/7/98	1/26/99
11	Pre-Engineered Metal Building Selection	40d	12/7/98	1/29/99
12	Transformer Design	26d	12/21/98	1/25/99
13	Filter Press Selection	39d	12/7/98	1/28/99
14	Clarifier Design	37d	12/7/98	1/26/99
15	GAC Contactor Design	40d	12/7/98	1/29/99
16	Instrumentation and Control System Design	26d	12/23/98	1/27/99
17	MCC Unit Design	27d	12/23/98	1/28/99
18	Pump Selection	38d	12/7/98	1/27/99
19	Blower Selection	35d	12/15/98	2/1/99
20	PLC and SCADA System Design	27d	12/28/98	2/2/99
21	Complete Design and Drawing Package	20d	1/28/99	2/24/99
22	Distribute Construction Drawings	0d	3/1/99	3/1/99
23				
24				



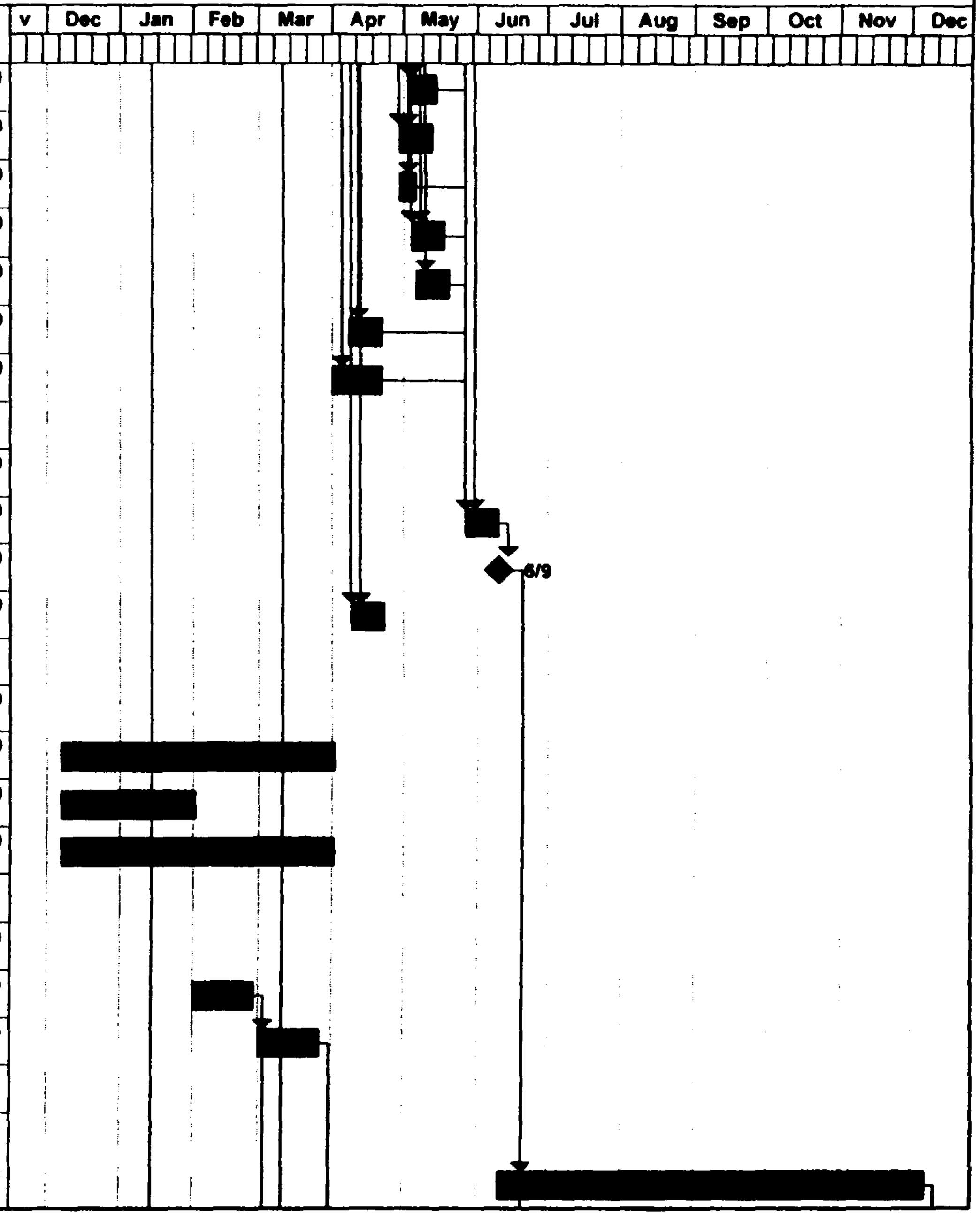
Baldwin Park Operable Unit
Phase 2 Groundwater Treatment System
DESIGN - BUILD PROJECT SCHEDULE

ID	Task Name	Dur	Start	Finish
25	**Procurement Phase**	70d	2/4/99	5/12/99
26	GAC/FB Bioreactor	70d	2/4/99	5/12/99
27	UV/Oxidation System	41d	2/4/99	4/1/99
28	Multi-Media Filters	53d	2/4/99	4/19/99
29	Pre-Engineered Metal Buildings	60d	2/4/99	4/28/99
30	Transformer	60d	2/4/99	4/28/99
31	Filter Press	60d	2/4/99	4/28/99
32	Clarifier	63d	2/4/99	5/3/99
33	GAC Contactors	65d	2/4/99	5/5/99
34	Instrumentation and Control	45d	2/4/99	4/7/99
35	MCC Units	40d	2/4/99	3/31/99
36	Pumps	70d	2/4/99	5/12/99
37	Blowers	70d	2/4/99	5/12/99
38	PLC and SCADA System	40d	2/4/99	3/31/99
39	PLC and SCADA Software	30d	2/26/99	4/8/99
40				
41	**Construction Phase**	68d	2/22/99	5/26/99
42	Mobilization	0d	2/22/99	2/22/99
43	Install Fire Line and Sewer Line	10d	2/22/99	3/5/99
44	Foundation and Pad Construction	25d	2/22/99	3/26/99
45	Underground Piping Installation	15d	3/8/99	3/26/99
46	GAC/FB Bioreactor Installation	10d	5/13/99	5/26/99
47	UV/Oxidation System Installation	10d	4/2/99	4/15/99
48	Multi Media Filter Construction	25d	3/29/99	4/30/99



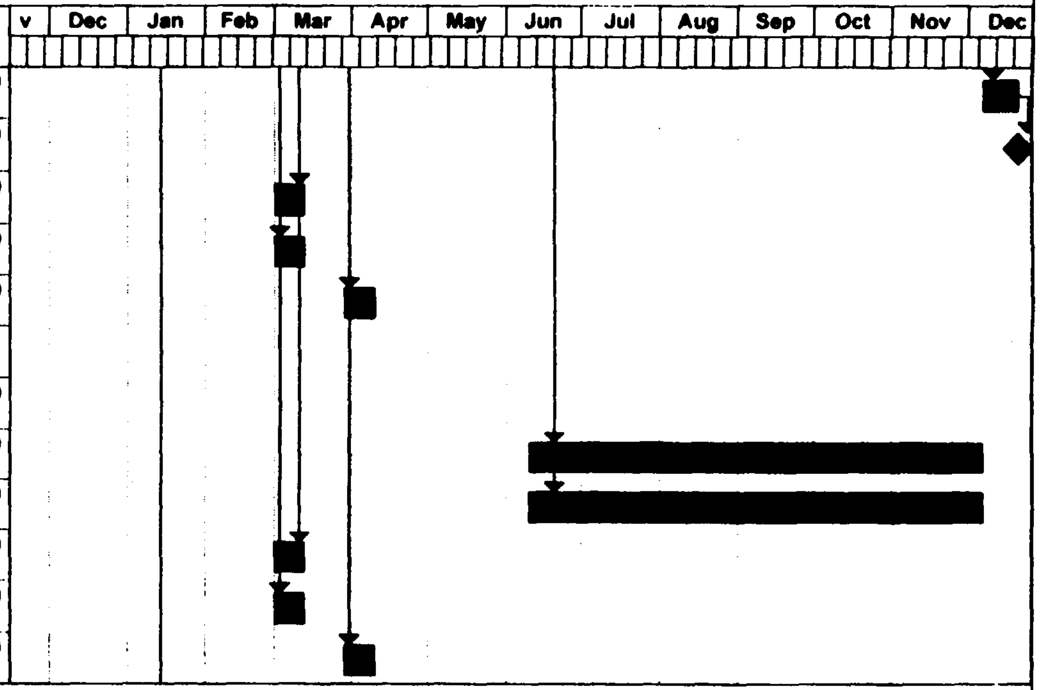
Baldwin Park Operable Unit
Phase 2 Groundwater Treatment System
DESIGN - BUILD PROJECT SCHEDULE

ID	Task Name	Dur	Start	Finish
49	Multi-Media Filter Installation	10d	5/3/99	5/14/99
50	Pre-Engineered Building Erection	10d	4/29/99	5/12/99
51	Transformer Installation	5d	4/29/99	5/5/99
52	Reclamation System Installation	10d	5/4/99	5/17/99
53	GAC Contactors Installation	10d	5/6/99	5/19/99
54	Instrumentation Installation	10d	4/8/99	4/21/99
55	MCC Installation	15d	4/1/99	4/21/99
56				
57	**Start-Up and Operation**	**44d**	**4/9/99**	**6/9/99**
58	Plant Start-Up	10d	5/27/99	6/9/99
59	Plant Operational	0d	6/9/99	6/9/99
60	PLC and SCADA System Installation	10d	4/9/99	4/22/99
61				
62	**Permitting**	**84d**	**12/7/98**	**4/1/99**
63	Regional Board Discharge permit	84d	12/7/98	4/1/99
64	ATF Permit	41d	12/7/98	2/1/99
65	Chemical Sourcing and Certification Permit	84d	12/7/98	4/1/99
66				
67	**Manual Preparation**	**40d**	**2/1/99**	**3/26/99**
68	Operations and Maintenance Manual	20d	2/1/99	2/26/99
69	Sampling and Analysis Plan	20d	3/1/99	3/26/99
70				
71	**DHS Submittals**	**211d**	**3/1/99**	**12/20/99**
72	Collect Plant Performance Data	128d	6/10/99	12/6/99



Baldwin Park Operable Unit
Phase 2 Groundwater Treatment System
DESIGN - BUILD PROJECT SCHEDULE

ID	Task Name	Dur	Start	Finish
73	Prepare Performance Report	10d	12/7/99	12/20/99
74	Submit Plant Performance Report	0d	12/20/99	12/20/99
75	Design-Build Package Review	10d	3/1/99	3/12/99
76	O&M Manual Review	10d	3/1/99	3/12/99
77	SAP Review	10d	3/29/99	4/9/99
78				
79	**EPA Submittals**	**201d**	**3/1/99**	**12/6/99**
80	Bi-Weekly Interim Performance Reporting	128d	6/10/99	12/6/99
81	Monthly Written Performance Report	128d	6/10/99	12/6/99
82	Design-Build Package Review	10d	3/1/99	3/12/99
83	O&M Manual Review	10d	3/1/99	3/12/99
84	SAP Review	10d	3/29/99	4/9/99



DISTRIBUTION

Final
Phase 2 Treatability Study Work Plan
Pilot-scale Groundwater Treatment System
Baldwin Park Operable Unit
San Gabriel Basin, California

February 12, 1999

Copy No.

Copies 1-34:	Baldwin Park Operable Unit Steering Committee Members and Consultants
Copy 35:	Wayne Praskins US EPA Region IX 75 Hawthorne Street San Francisco, CA 94105-3901
Copies 36-47:	Other Interested Parties
Copies 48-60:	HLA Project File

Quality Control Reviewer

/FOR
James I. Michael, P.E.
Managing Principal Engineer